



Toward Improved Land Surface Initialization in Support of Regional WRF Forecasts at the Kenya Meteorological Service (KMS)

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Talk Outline

International collaborating organizations

- *NASA Short-term Prediction Research and Transition (SPoRT)*
- *NASA SERVIR / SERVIR-Africa*
- *Regional Center for Mapping of Resources for Development (RCMRD)*
- *Kenya Meteorological Service (KMS)*

Experiment design / modeling & verification tools

- *NASA Land Information System (LIS)*
- *Weather Research and Forecasting (WRF) model*
- *Model Evaluation Tools (MET) & SPoRT-MET script package*

LIS Spin-up Run

Sample Model Output and Verification Statistics

Future Efforts



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International Collaboration

SPoRT/SERVIR/RCMRD/KMS Collaboration: Builds off strengths of each organization

- SPoRT: Transition of satellite, modeling and verification capabilities
- SERVIR-Africa/RCMRD: International capacity-building expertise
- KMS: Operational organization with regional weather forecasting expertise in East Africa



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Hypothesis and Experiment Design

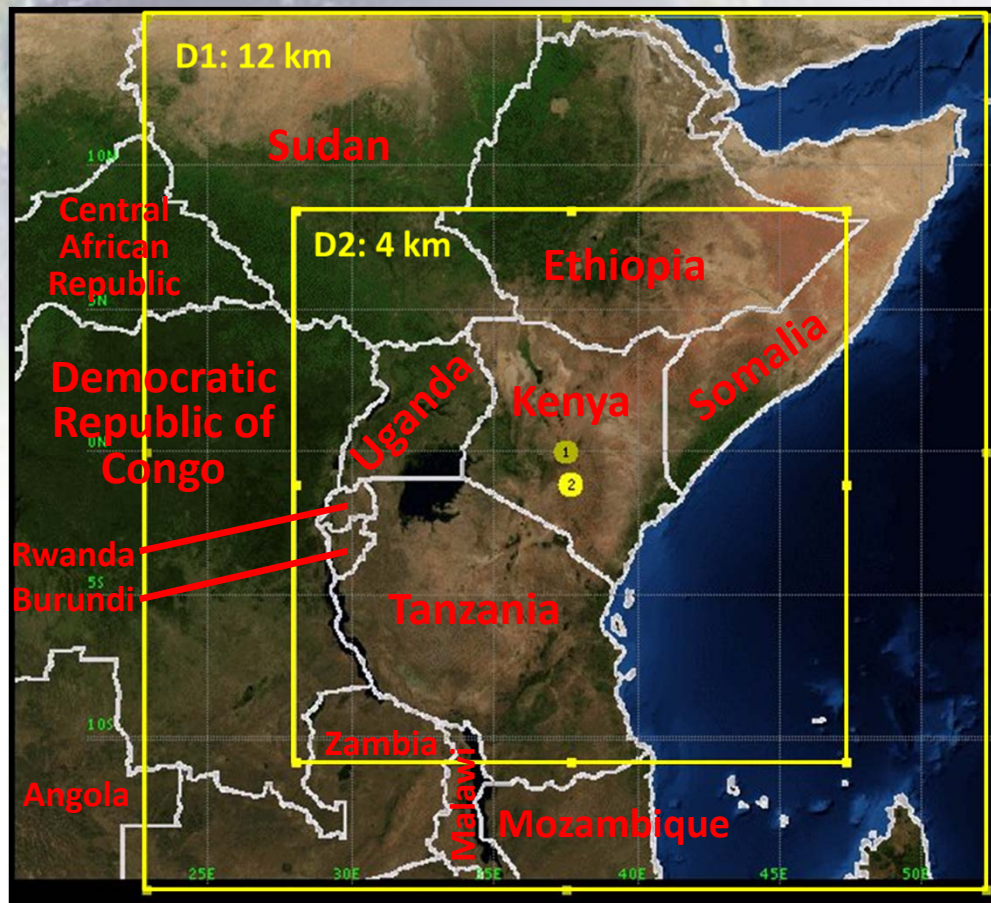
- Hypothesis: *Improved land-surface initialization over Eastern Africa can lead to better temperature, moisture, and ultimately precipitation forecasts in NWP models*
 - KMS currently initializes Weather Research and Forecasting (WRF) model with NCEP/Global Forecast System (GFS) model 0.5-deg initial / boundary condition data
 - LIS will provide much higher-resolution land-surface data at a scale more representative to regional WRF configuration
 - Future implementation of real-time NESDIS/VIIRS vegetation fraction to further improve land surface representativeness



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WRF/EMS Configuration & Daily Simulations



Environmental Modeling System (EMS)
Advanced Research WRF 12-km/4-km
1-way nest domain

Once-daily Control / Experiment runs:

- 00z initialization; 48-h integration
- Control: GFS ICs / BCs
- Experiment: Same as control, but with LIS LSM initialization
- 72 second timestep on D1
- 42 vertical levels; 30-mb ptop

Physics parameterizations:

- RRTM-G SW/LW radiation
- Kain-Fritsch convection (D1 only)
- Noah Land Surface Model (LSM)
- Lin microphysics
- MYNN 2.5 TKE PBL scheme

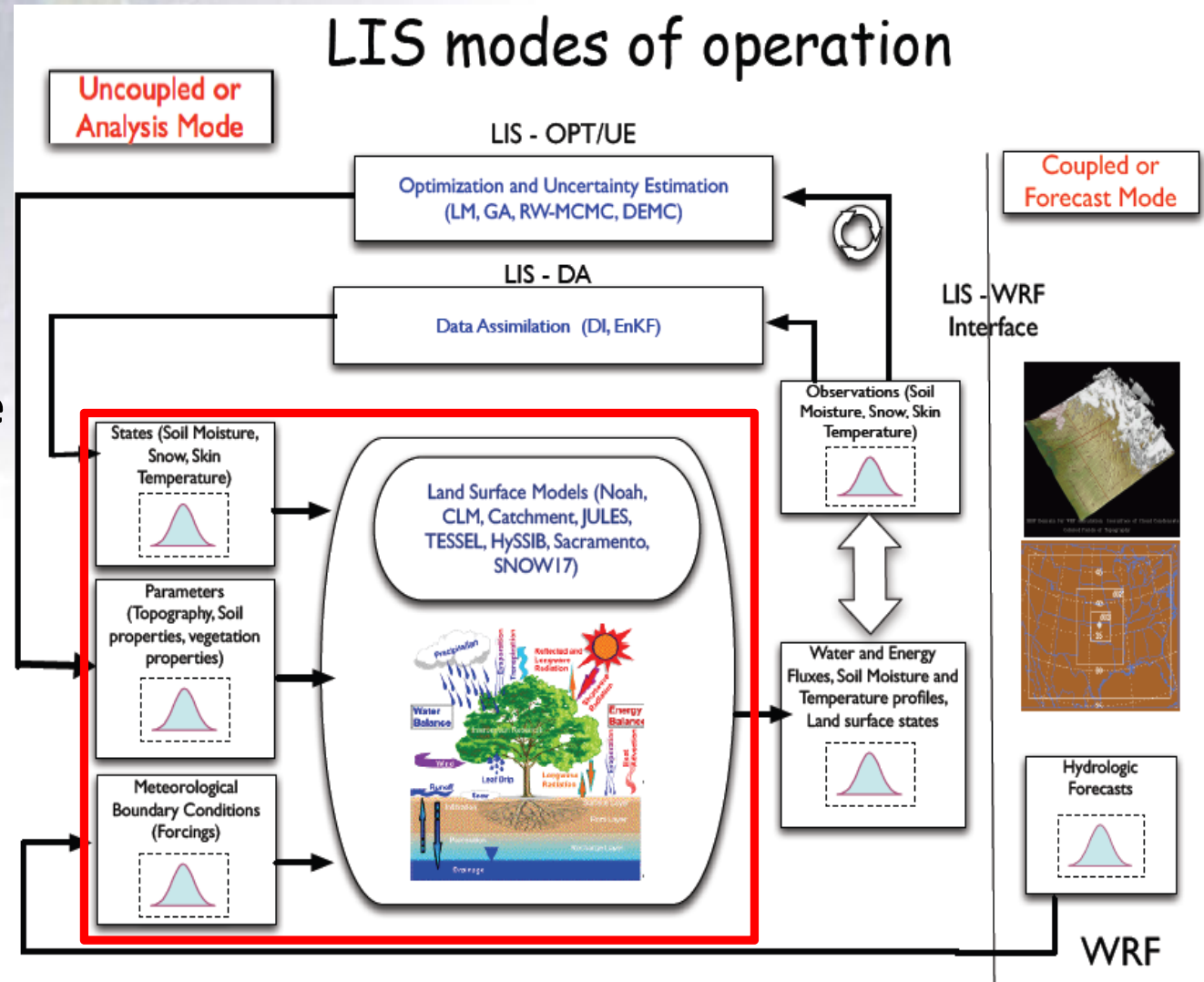
Land Information System (LIS)

High-performance land surface modeling & data assimilation system

Uncoupled/analysis mode

Forecast mode coupled to WRF model

This experiment uses uncoupled/analysis mode



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LIS-Noah Configuration and Spin-up

LIS uncoupled run of Noah LSM

- Horizontal grid spacing of 0.03-deg (~3 km)
- Grid covers outer WRF model domain
- LIS-Noah cold-started on 1 Jan 2011; run through Summer 2013
 - Uniform initial volumetric soil moisture (20 %) and temperature (290 K)
 - Atmospheric forcing: Global Data Assimilation System (GDAS)
 - Precipitation forcing comparison: (1) GDAS precip rates, (2) TRMM 3-h precip (~25 km), and (3) CMORPH half-hourly precip (~8 km)
- Chose the **CMORPH precip forcing**; results compared favorably with TRMM precip product, but with slightly more detail
- Developed initialization option for WRF EMS



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LIS-Noah Spin-up Mar 2011 – Apr 2013:

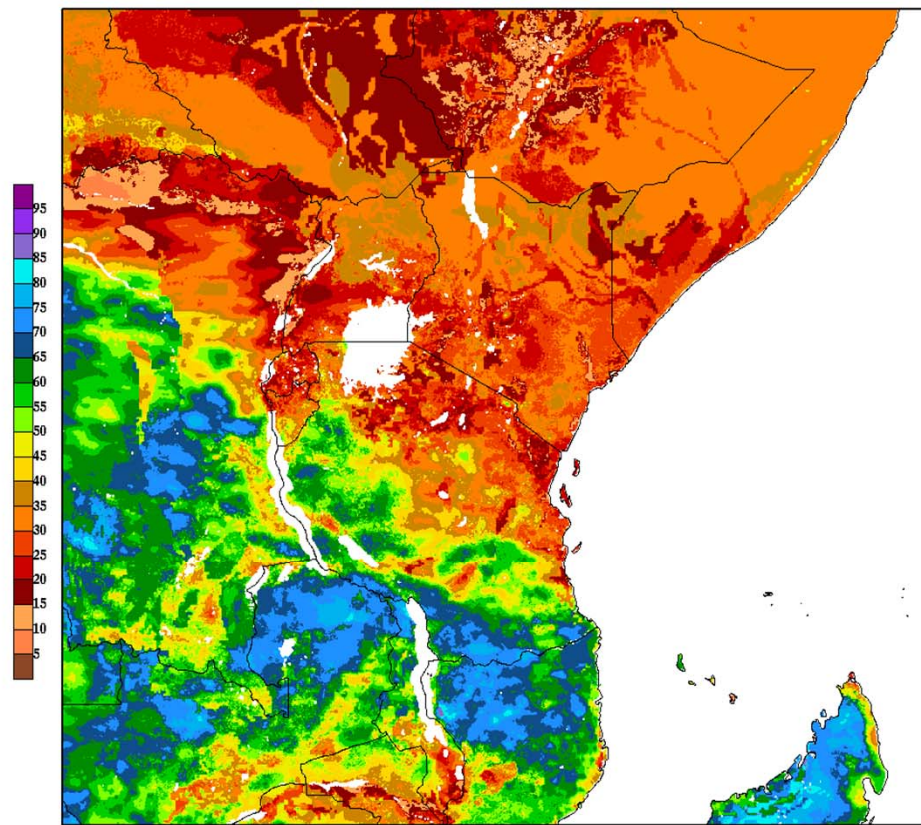
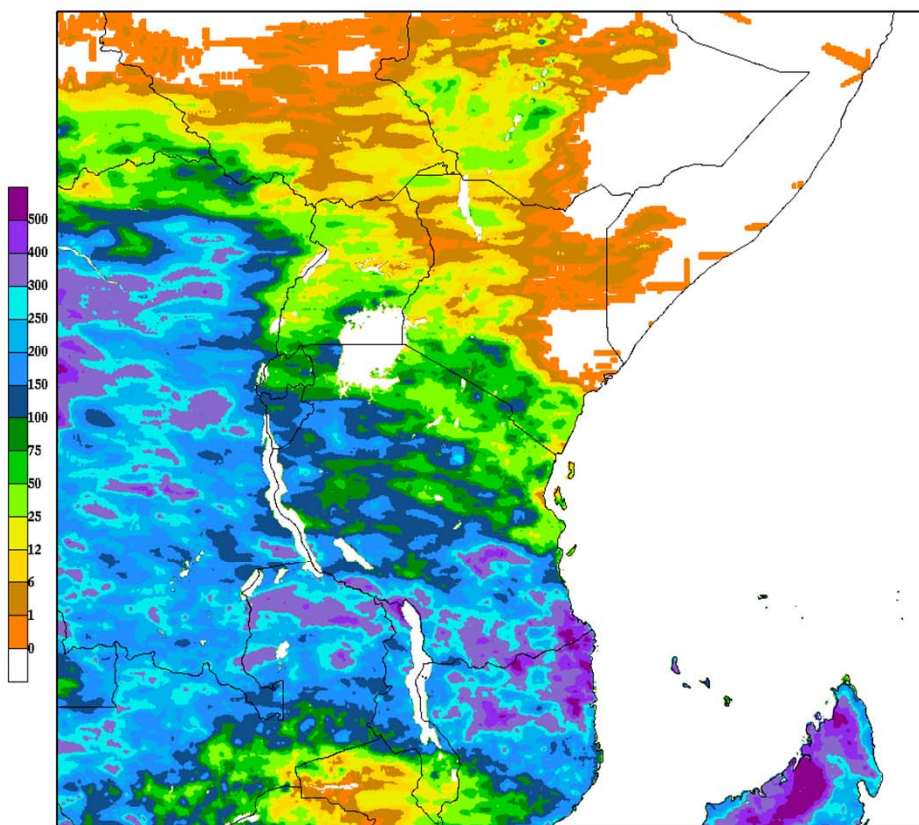
*30-day Precipitation and Soil Moisture Fields Show
Seasonal Oscillation of Intertropical Convergence Zone*

CMORPH 30-day Precipitation

LIS-Noah Column Relative Soil Moisture

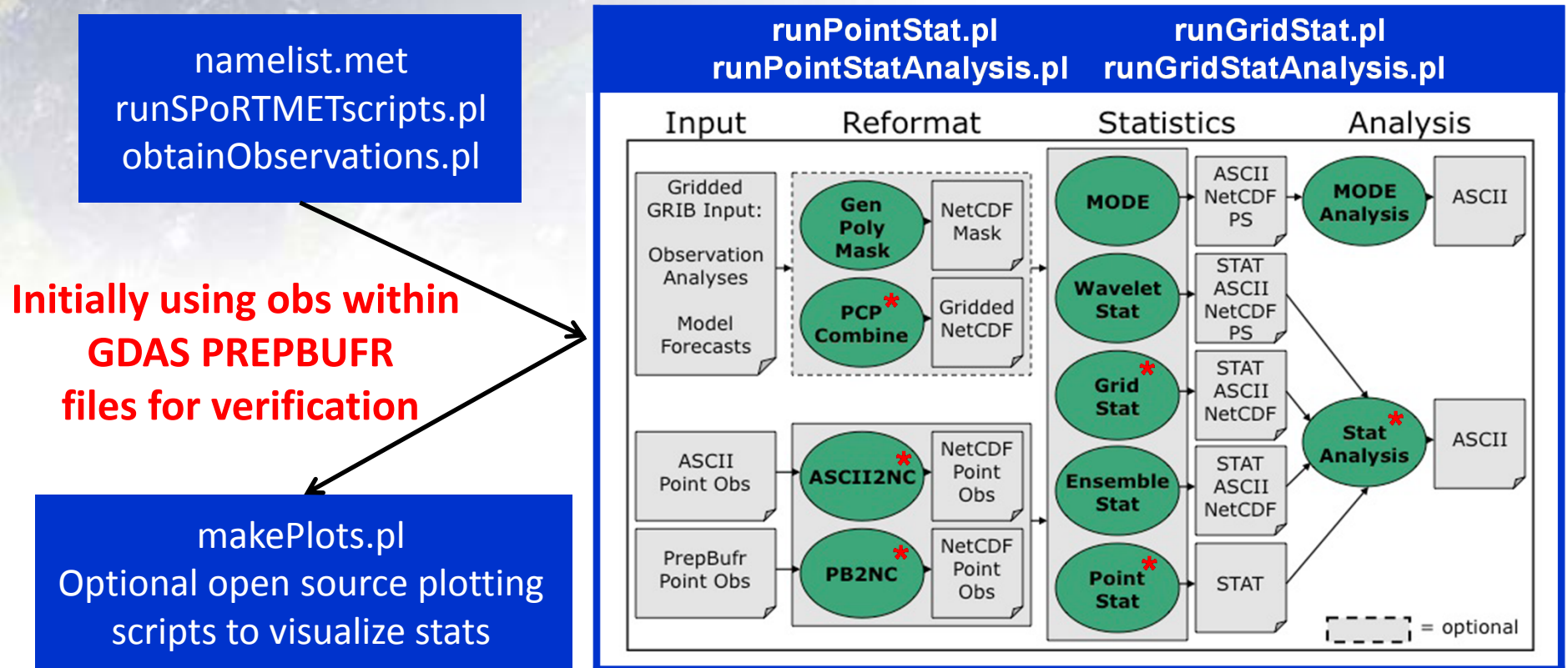
Accumulated precip (mm) for KMD-CMORPH valid 110302/0000V000

Integrated Relative SM (%) for KMD-CMORPH valid 110302/0000V000



NCAR/MET and SPoRT Scripting Package

- SPoRT-developed scripting package to manage data acquisition, execute MET, and produce quick statistics plots (**Zavodsky et al. poster 500; 30 EIPS**)
- Designed to work with WRF EMS output GRIB1 or GRIB2 files



NCAR Model Evaluation Tools (MET)



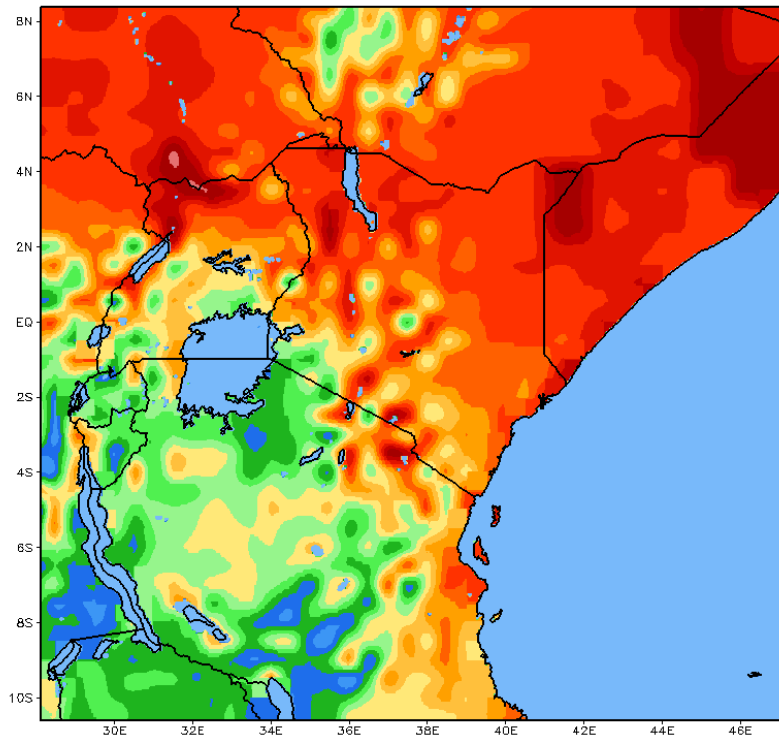
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Differences in Land Surface Initialization: (25 Jan 2014; GFS vs. LIS 0-10 cm soil moisture; 4-km WRF)

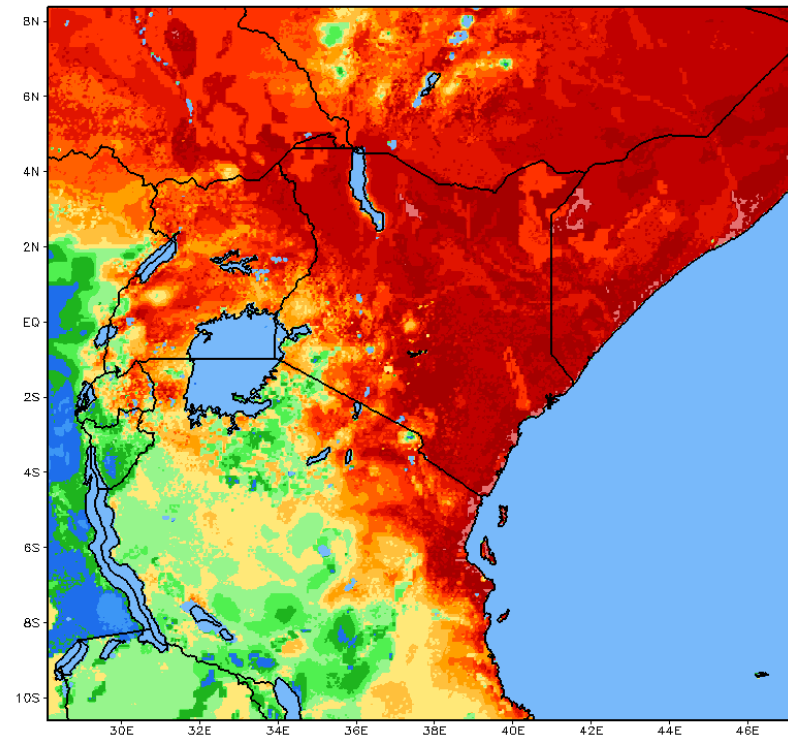
4-km domain Control (GFS)

0-10 cm Volumetric Soil Moisture ($\text{m}^3/\text{m}^3 \times 100$)
Control 0-h Forecast Valid: 00Z 25 JAN 2014

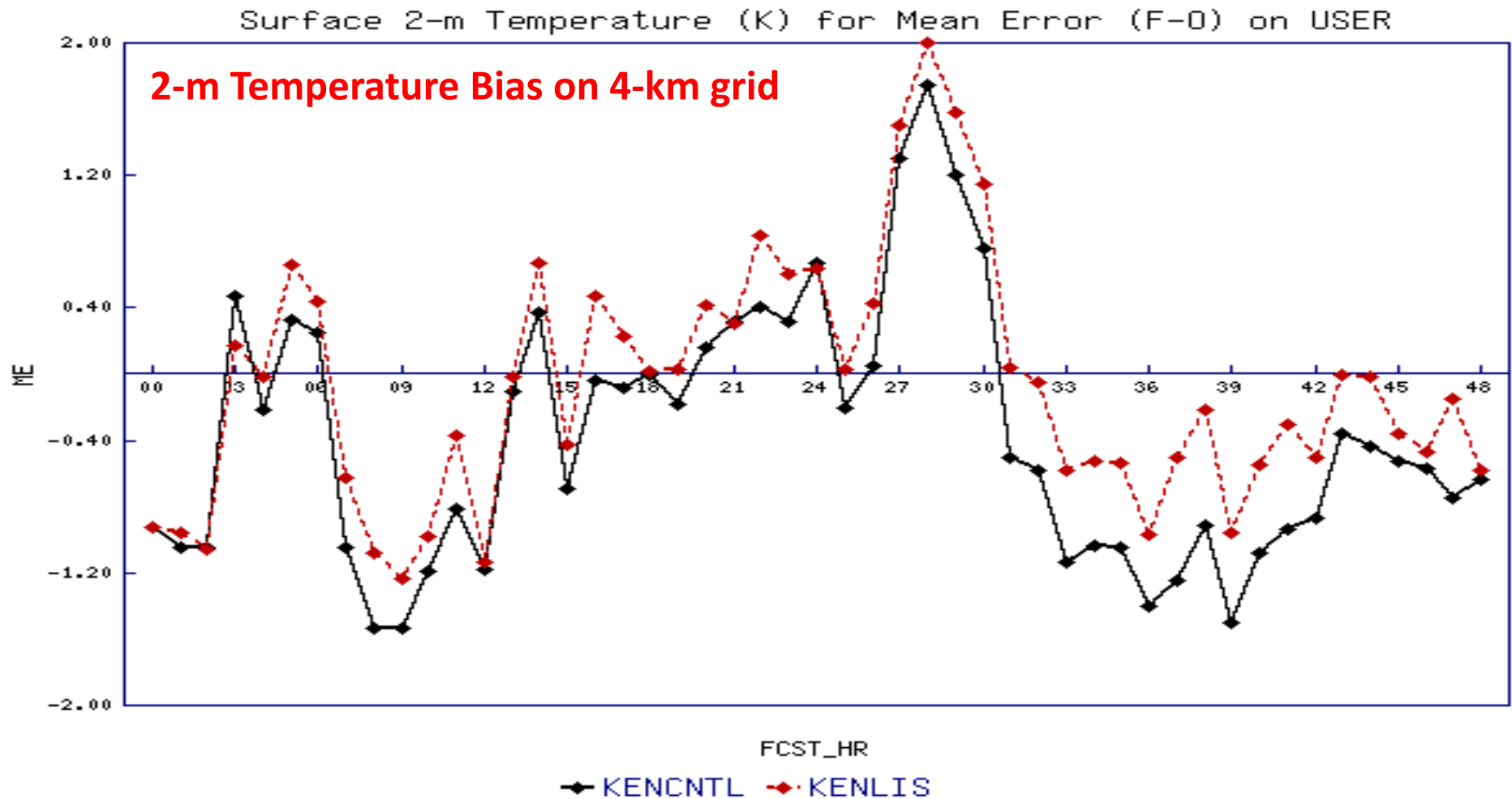


4-km domain Experiment (LIS)

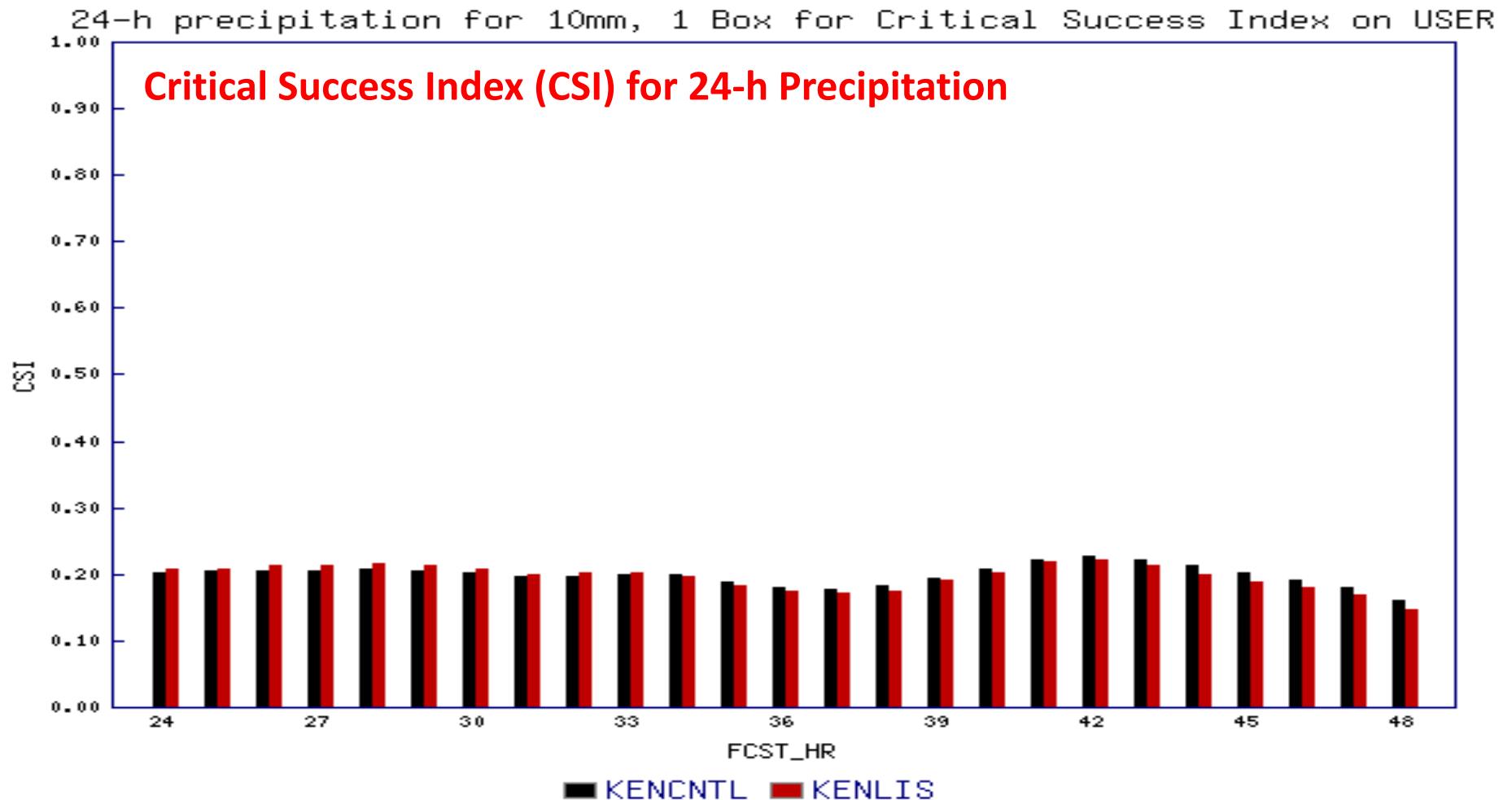
0-10 cm Volumetric Soil Moisture ($\text{m}^3/\text{m}^3 \times 100$)
LIS 0-h Forecast Valid: 00Z 25 JAN 2014



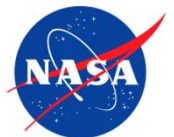
4-km WRF Forecast 2-m Temperature: 25 Jan 2014



4-km WRF Forecast Precipitation: 25 Jan 2014



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Future Work

- Future work
 - Seasonal composites of verification with SPoRT-MET scripts
 - Collecting daily MET verification statistics for Control and LIS
 - Compute seasonal composite verification scores
 - Implement daily NESDIS/VIIRS vegetation into LIS & WRF runs
 - Daily global 4-km resolution green vegetation fraction (GVF)
 - To replace coarse-resolution, outdated monthly GVF climatology
 - Document possible improvements to verification scores
 - Site visit to KMS/RCMRD/SERVIR-Africa
 - Training and transition of SPoRT-MET scripts for KMS
 - Enhance collaborations between SPoRT, SERVIR, and KMS/RCMRD
 - Soil moisture data assimilation: SMOS and SMAP missions
- Questions / comments?



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Back-up Slides



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International Collaboration

Short-term Prediction Research and Transition (SPoRT)

- Transitions unique NASA / NOAA observations and research capabilities to the operational weather community to improve short-term weather forecasts on regional and local scales
- Proven paradigm for transition of research and experimental data to ops

NASA SERVIR Project: Connecting Space to Village

- NASA-USAID partnership to enable use of Earth observations in developmental decision making
- Identifies needs in regions and links science products from U.S. institutions to meet those needs through improved access to data, models & products

Regional Center for Mapping of Resources for Development (RCMRD)

- RCMRD has mandate to work with 19-member countries to build their capacities for geospatial information; RCMRD is host of SERVIR-Africa

Kenya Meteorological Service (KMS)

- Meteorological/climatological services to agriculture, forestry, water resources management, civil aviation and private sector
- Met. services for shipping in West. Indian Ocean; issues cyclone warnings



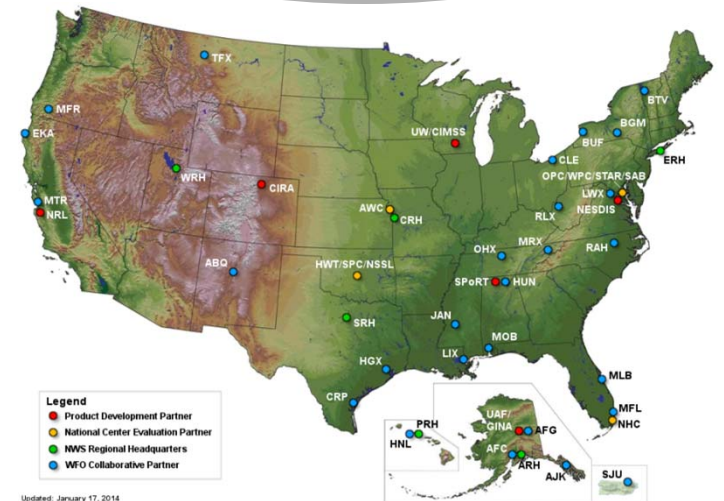
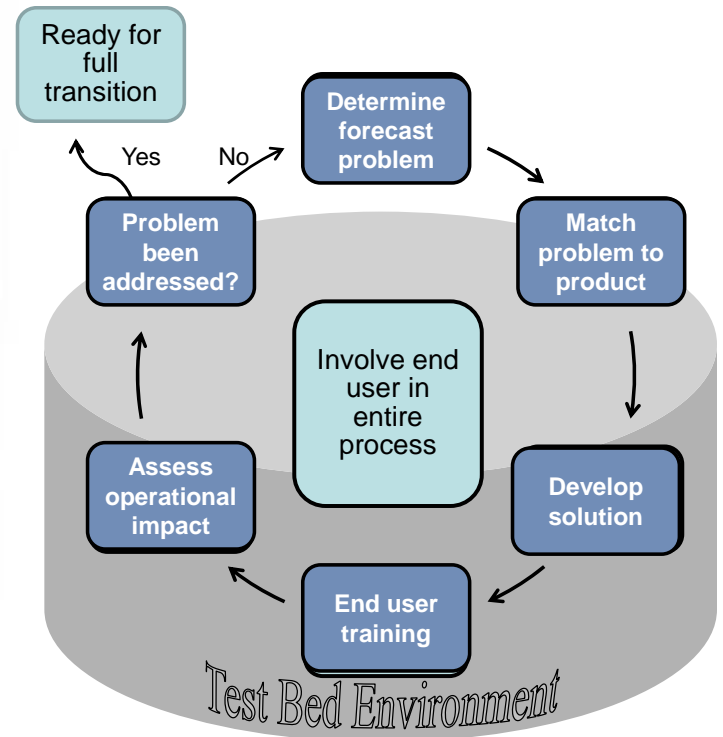
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SPoRT Center

Short-term Prediction Research and Transition (SPoRT)

- Transitions unique NASA and NOAA observations and research capabilities to the operational weather community to improve short-term weather forecasts on regional and local scales
- ***Proven paradigm for transition of research and experimental data to operations***
- Close collaboration with numerous NWS WFOs across the U.S.
- Began in 2002; co-funded by NOAA since 2009 through “proving ground” activities



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NASA SERVIR Project: Connecting Space to Village

SERVIR is a NASA-USAID partnership to enable use of Earth observations in developmental decision making

SERVIR identifies needs in the regions and links science products from U.S. institutions to meet those needs through improved access to data, models and products



In East Africa, SERVIR is working through SERVIR-Africa, a project at the Regional Center for Mapping of Resources for Development (RCMRD)



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